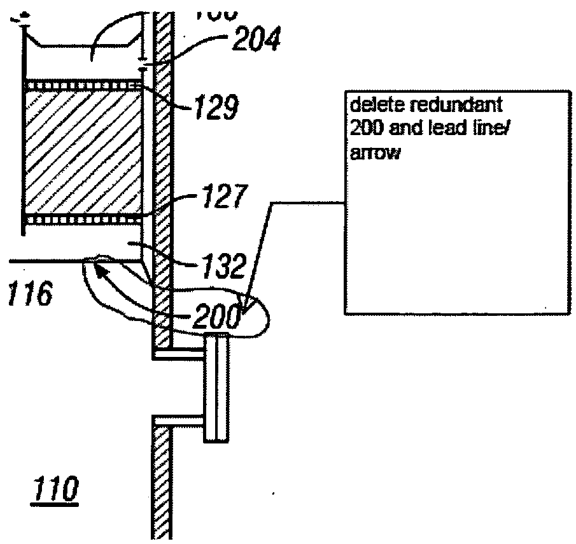
DRAWINGS AMENDMENT ANNOTATIONS

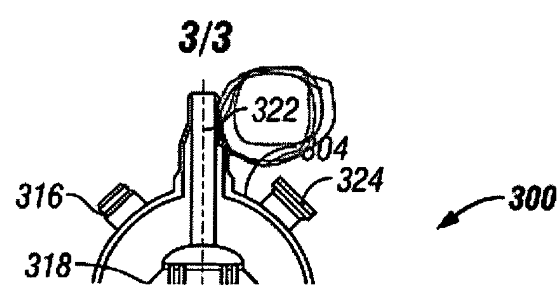
Replacement Sheet 2 is attached hereto in which Fig. 2 is amended to delete one of the redundant 200 reference numerals as shown in the following cropped markup:



REMARKS

The drawings are amended by Replacement Sheet 2 appended hereto; claims 3, 5-6, 9-12, and 14-15 are amended, claim 13 canceled and new claims 17-21 presented; claims 1-12 and 14-21 are pending in the application. The drawings were objected to; claims 6, 7 and 16 stand rejected as anticipated by *Notman* (US4311671); and claims 1-5 and 8-15 stand rejected as obvious from *Notman*, *LeBlanc* et al. (US5736116) and/or *Topsoe* et al. (US4181701). Further examination of the application as amended and reconsideration of the objections and rejections are respectfully requested.

Fig. 2 is amended to remove one of the redundant reference numeral 200's. The office action also objected to the drawings in that reference numeral 322 mentioned at paragraph 28 was said not to be found in the drawings. However, it appears the presence of the reference numeral in the upper central portion of Fig. 3 may have been overlooked as indicated in the following cropped portion of Fig. 3:



Claims 3, 9, 11-12 and 15 are amended to clarify that it refers to the upright cylindrical shell of the vessel, not to be confused with the shell of the shell-and-tube heat exchanger. Claim 5 is amended to clarify that the annular flow passages are necessary only to bypass the upper one of the catalyst beds. Claim 6 amended to clarify that the annulus of the catalyst volumes per se are around the heat exchanger and not axially offset therefrom. Claims 9 and 12 are also amended to specify that the support cone forms a gas seal across the annulus between the vessel and the outer shroud of the at least one fixed bed zone. Claim 10 is amended to depend from claim 6 in which proper antecedents are found. Claim 14 is amended to depend from claim 12 and recite the features originally presented in claim 13, which has been canceled. Support for the subject matter of the claim amendments is thus found in the claims as originally presented, the specification and/or the drawings, and no new matter is presented.

With respect to claim 6, the office action asserts *Notman* at Fig. 5 which shows the heat exchanger 40 disposed vertically above the catalyst zones. In contrast, claim 6 specifies an annular housing for the catalyst volumes formed by inner and outer concentric shrouds around a shell and tube heat exchanger, which, although not believed to be necessary, has been clarified by the present amendment to reflect the intent that the catalyst

volumes are disposed in an annular configuration around the centrally disposed shell and tubes of the heat exchanger. Respectfully, the *Notman* catalyst beds 12B' and 12B'' are not disposed around the heat exchanger 40, which is vertically displaced and radially overlaps any catalyst annulus. Further, the double pipe arrangement of tubes 26, 42 does not meet the understanding of one skilled in the art of a shell-and-tube heat exchanger and would in any case result in tube-side fluid inlet/outlet cross exchange and disadvantageous heating of the effluent gas in pipe 42 fed to the subsequent catalyst stage.

Moreover, the recitation in claim 6 of "a discharge passage in fluid communication between the upper and lower discharge plenums and a shell-side fluid inlet to the heat exchanger" is not met in *Notman* by alleged shell-side feed gas inlets 34, 30, 28A. In claim 6, the discharge plenums are connected by a passage to the shell side of the heat exchanger; in *Notman*, the discharge plenums feed into pipe 26, up to the tube-side of the exchanger 40 where they are cooled and thence to the final catalyst stage via central pipe 42. The tube-side *Notman* configuration of the pipes 26, 42 in a pertinent cropped portion of Fig. 5 is more easily seen by reference to the similar arrangement in the corresponding cropped portion of Fig. 1:

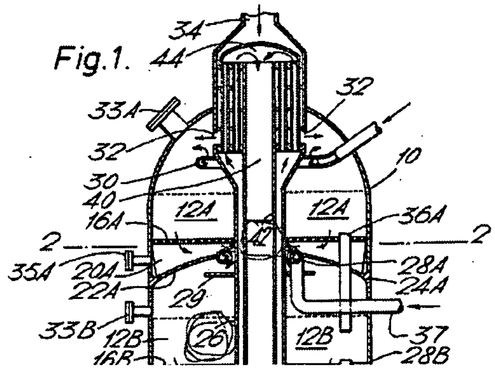


Fig. 1.

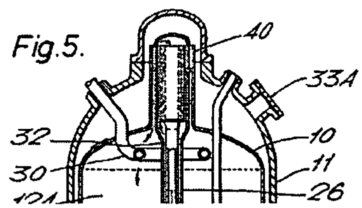


Fig. 5.

Furthermore, the feed gas from inlet 34 in *Notman* is supplied to the shell-side of the exchanger 40 for heating before being introduced to the top of the uppermost catalyst bed 12A from the shell-side discharge. Supplemental gas feed from the spargers 28A, 30 is likewise fed as a direct quench to the catalyst bed inlets, and not to the tubes in the heat exchanger 40. *Notman* is thus directly contrary to claim 6 in which, since the heat exchanger is within and encircled by the catalyst bed, the catalyst bed effluent can be conveniently and advantageously supplied to the shell side without the need for any pipes to/from a vertically offset location as in *Notman*. This allows applicant's invention to have a modular construction (see claim 15), and can advantageously reduce the vertical height of the reactor generally by the length of the *Notman* heat exchanger or catalyst zone. It is respectfully submitted that *Notman* does not teach or suggest each of the features of claim 6, and should thus be withdrawn as a reference. Claims 7, 8 and 16 depend from claim 6 and are likewise allowable.

New claims 18 and 19 depend from claim 1 and further emphasize the distinctions from *Notman* Fig. 5. Claim 18 specifies that the inner shroud of the catalyst housing forms the shell-and-tube heat exchanger shell circumscribing the exchanger tubes, whereas in *Notman* the pipes 26, 42 are extended separately to a location remote from the housing. Claim 19 specifies a seal between the outer shroud and the upright cylindrical shell of the vessel to prevent gas from bypassing the fixed bed zone, contrary to *Notman* wherein the feed gas from 34 passes around the cartridge 10 in the annulus between the catalyst beds and the vessel wall, up to the heat exchanger 40 before being introduced to the top of the first catalyst bed. The seals (166, 202) have the advantage of separately supporting each catalyst zone from the top or bottom to minimize the effects of thermal stresses as disclosed in the specification at paragraph 26, whereas in *Notman* one cartridge must be employed containing all the catalyst zones and beds integrated within it due to the bottom support seen in Fig. 5.

With respect to claim 1, *Notman* is alleged in the office action to disclose everything recited except for the specific catalyst types, which are said to be obvious from *LeBlanc*. Claim 1 specifies at least three catalyst zones, with the intermediate zones each comprising upper and lower catalyst volumes. Each catalyst zone is associated with a respective shell and tube

heat exchanger around which the catalyst zones are disposed. In contrast, *Notman* discloses only one shell-and-tube heat exchanger vertically spaced from the catalyst zones, and none of the catalyst zones are disposed about a respective shell-and-tube heat exchanger. *Notman* teaches squarely away from the approach of applicant in that interstage 'cooling' of the additional stage is effected instead by introducing cold feed gas via sparger 28A, for example. *Leblanc* would not have bridged that gap. Claims 2-4 are allowable as depending from claim 1.

In claim 5, the gas flow split is effected by annular passages around the upper catalyst beds with the added benefit that it can shorten the height of the reactor, see paragraph 26. *Topsoe* was cited against claim 5 in combination with *Notman* and *LeBlanc*, in that it allegedly suggested relocating the *Notman* passages to be annularly arrayed about the catalyst beds to achieve heat exchange temperature control as well as facilitating catalyst replacement. Office Action, pp. 6-7. However, *Topsoe* is a radial-flow reactor design wherein the gas flows radially through the annular catalyst beds between perforated cylinders, and thus does not provide any guidance or motivation for supplying/recovering axial flow gases from the upper and lower ends of the catalyst beds. Note that there are no gas flow passages between the first and second beds near the panel 26.

Catalyst bed design in a radial-flow reactor like Topsoe is fundamentally different from the axial-flow reactor with which applicant is concerned. Contrary to the assertions in the office action, with respect, radial-flow reactors like *Topsoe* require the use of a freeboard or other catalyst volume that is ineffective to avoid catalyst fluidization at the upper end of the radial flow catalyst volume, and generally complicate catalyst loading and removal. See applicant's specification at paragraph 4. Thus, rather than suggest any modification of an axial-flow design, *Topsoe* teaches squarely away from the axial flow design of claim 5.

As a result, the annular spaces in *Topsoe* are for supplying reactant gas sequentially *in series* to the perforated cylinder of each catalyst bed. Even the interstage direct quench "by-pass stream of synthesis gas" in *Topsoe* is supplied via inlet 14 and does not flow through an annular passage to bypass the first catalyst bed. "Bypass" in the sense of *Topsoe* means it is the *heat exchanger 41* that is bypassed, via inlet 14 directly to point 45 at the common axis for the catalyst beds, so that the temperature of the feed to the first bed can be controlled by adjusting the ratio of cold feed gas to heat-exchanged feed gas; no bypass of a catalyst bed comprising part of a catalyst zone is disclosed or suggested in the radial-flow configuration of *Topsoe*.

In contrast, applicant's apparatus uses the annular bypass to split the flow of the same feed gas for parallel flow to the different axial-flow beds in the same catalyst zone. The feed gas split is not employed for temperature control, only to ensure that the amount of feed gas is proportional to the catalyst volume, e.g. 50-50 in the case of two equal beds, to obtain the same extent of conversion and exotherm in each parallel-flow bed. Furthermore, the annular passages and annular beds in *Topsoe* would appear to *complicate* catalyst removal at 3/45-49, further teaching away from this approach.

It is respectfully submitted that there is no motivation, teaching or other guidance suggesting the purported combination of *Topsoe/Notman*, and if there were, such combination would not obtain applicant's invention. Respectfully, the rejection of claim 5 should be withdrawn.

Topsoe was also cited against claims 10 and 11 for its alleged disclosure of annular passages. The comments above with respect to *Topsoe* in relation to claim 5 are thus likewise applicable to the rejection of claims 10 and 11.

With respect to claims 9 and 12, *Notman* is cited for the alleged disclosure of "inverted conically shaped supports 24." However, the claims call for a conical member between the outer shroud and the vessel wall to form a gas seal therewith. The office action refers to a passage in *Notman*

(beginning at 7/60) discussing Fig. 3, clearly a detail of the "hot wall" embodiment of Fig.1 that does not employ the cartridge 10, which the office action previously identified as corresponding to the outer shroud that is found only in Fig. 5. *Notman* teaches no conical structure in the annulus between the pressure shell 11 in Fig. 5 and the wall of the cartridge 10; instead the 'outer shroud' of the cartridge 10 in Fig. 5 appears to be bottom-supported from the lower end of the vessel 11. There is no annular seal between the vessel wall and the cartridge 10, and indeed, Notman discloses that the feed gas from inlet 34 is allowed to pass through this annulus on the way to the heat exchanger 40. Indeed, even the annular members 24 with the plates 22A, 22B', or 22B" are not sealed, each of the latter being provided with a through flow passage and/or a bypass.

The conical supports for the catalyst zone have the further advantage of minimizing radial thermal stresses, while allowing axial expansion to occur. See paragraph 26. None of the prior art structures, features or elements cited in the office action are referred to as mechanically suggesting that the conical supports provide this unexpected result.

Claim 14 depends from claim 12 and is likewise allowable. New claim 19 depends from claim 6 and is similarly directed to the annular seal feature to prevent gas bypass, and is thus similarly allowable over *Notman*.

New claim 20 is an independent claim directed to an axial-flow, vertical ammonia converter comprising at least one uppermost or intermediate catalyst zone, with the split-flow arrangement and the central effluent heat exchanger, installed as a module supported via the vessel wall via a conical support ring forming a gas seal. Claim 21 depends from 20 and recites that the conical support ring is inverted (as in Fig. 2). These claims are likewise allowable for the reasons discussed above.

It is respectfully submitted that the present application is in condition for allowance. Should any issues remain that are appropriate to telephone resolution, please contact undersigned counsel.

Respectfully submitted,

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